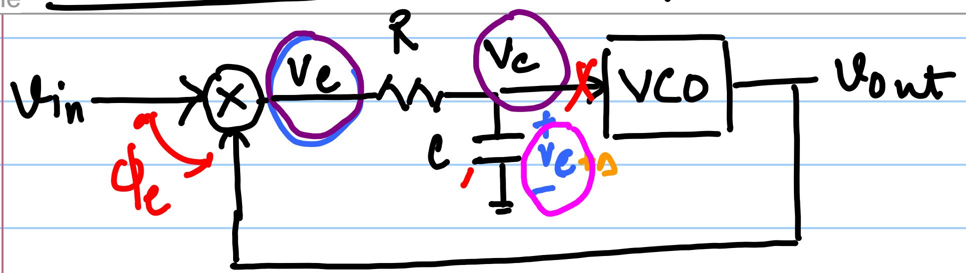
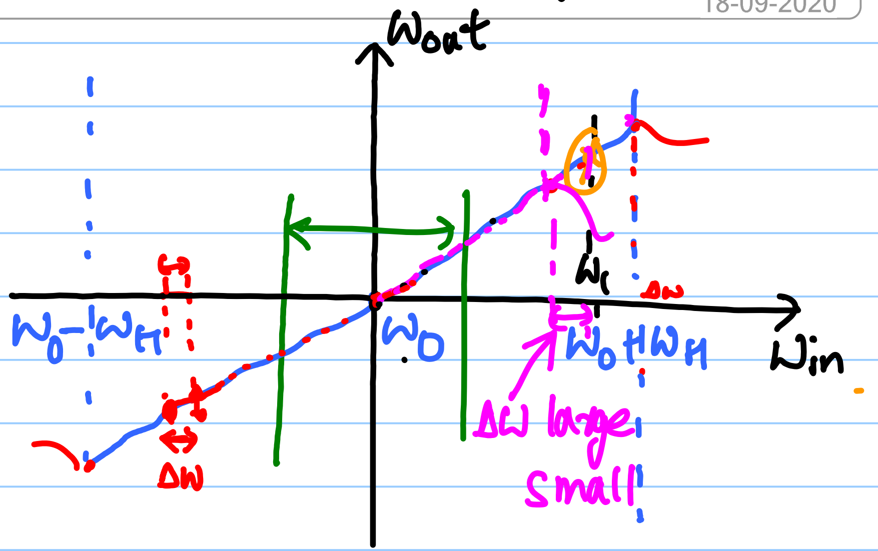
Note Title — 18-09-2020

Lecture #7 — Type-I, Order-2 — Hold-in (Tracking) Range





$V_{in} = \sin(\omega_{in} t - \phi_e)$

$V_{out} = \cos\left(\omega_{free} t + \int K_{vco} \cdot V_c \cdot dt + \phi_{os}\right)$

$V_e = \frac{1}{2}\left[\sin\left(\omega_{in} + \omega_{free} t + \int K_{vco} V_c\, dt + \phi_{os}\right) + \sin\left(\Delta\omega(0) - \int K_{vco} V_c\, dt - \phi_{os}\right)\right]$

$V_c = \frac{1}{2} \sin\left(\Delta\omega(0) - \int K_{vco} \cdot V_c\, dt - \phi_{os}\right)$

$\phi_e(t) = \Delta\omega(0) t - K_{vco}\int V_c \cdot dt - \phi_{os}$ ✓

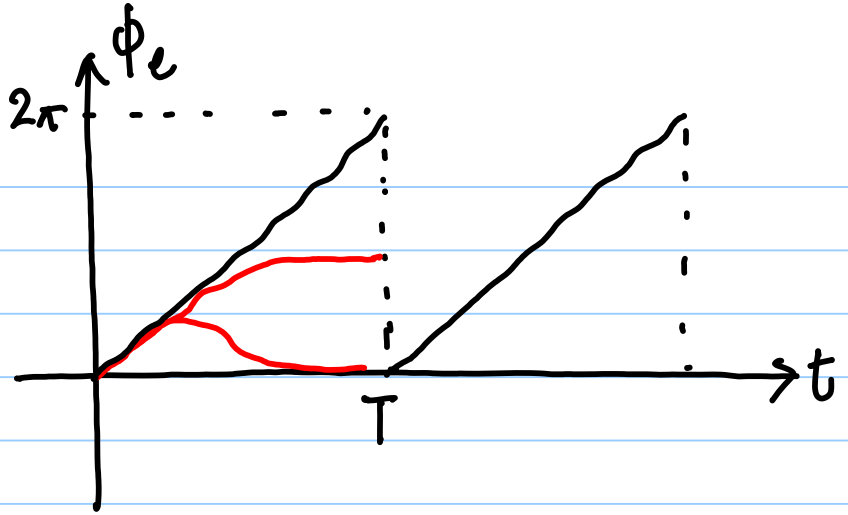
$\dot{\phi}_e(t) = \Delta\omega(0) - K_{vco} V_c = \Delta\omega(0) - K_{vco} \cdot K_{PD} \sin(\phi_e)$

$2\omega_H$: hold-in range.

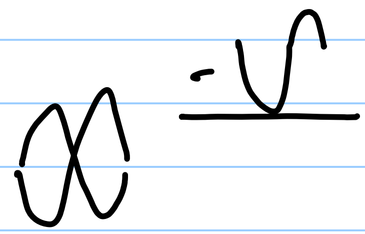
$\Delta\omega$ change is very small!

$\Delta\omega$ large : PLL loses lock.

$\frac{\omega_1 - \omega_{free}}{K_{vco}} = V_c = \frac{1}{2}\sin(\phi_e)$ — V_e

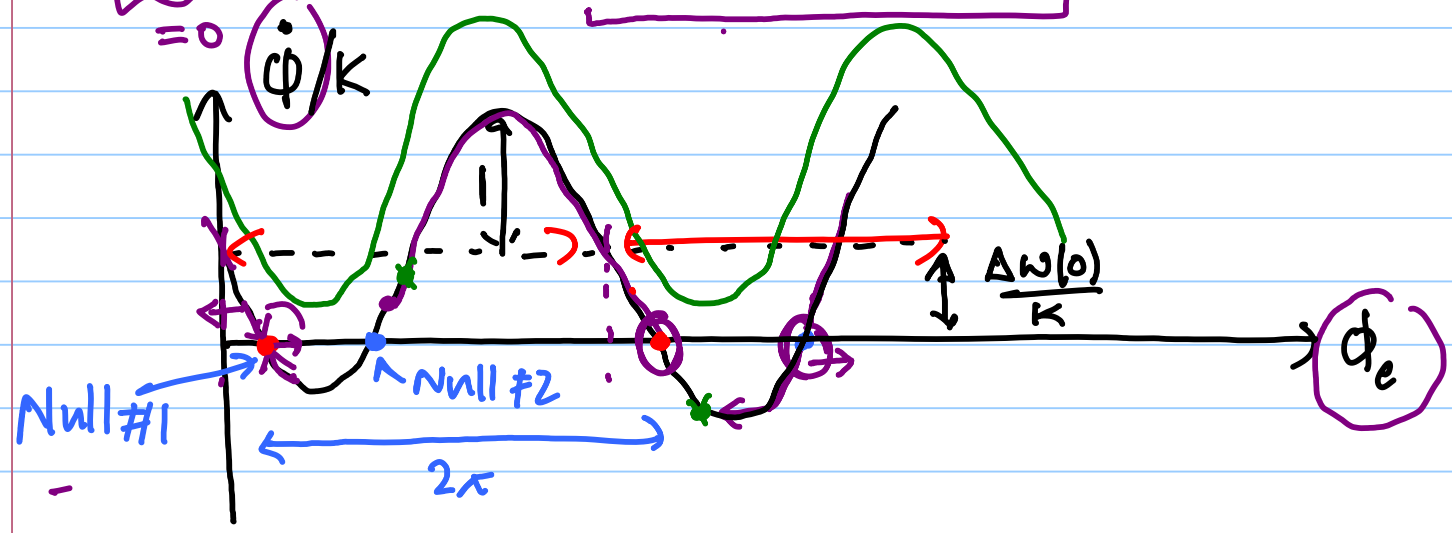


$T = \frac{2\pi}{\Delta\omega(0)}$



$\frac{1}{K}\frac{d\phi}{dt} = \frac{\dot\phi}{K} = \frac{\Delta\omega(0)}{K} - \sin(\phi_e)$ ✓

$= 0$



$\Delta\phi_e$ +ve

$\frac{d\phi_e}{dt} =$ -ve

$\frac{\Delta\omega(0)}{K} \leq 1 \Rightarrow$ $\boxed{\Delta\omega(0) \leq K}$ Lock-in range

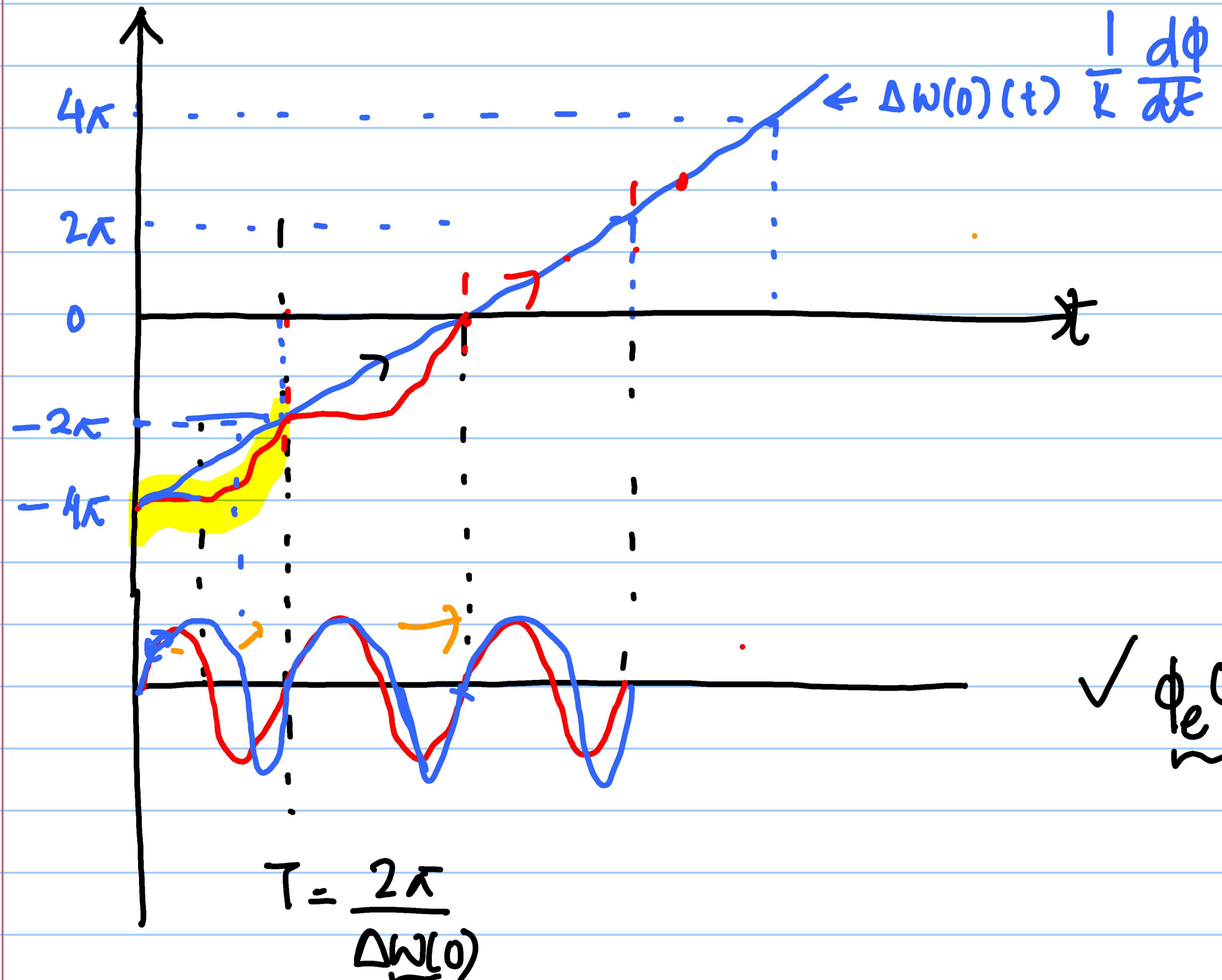
$\Delta\omega(0) > K$

Pull-in range $\Delta\omega_p$: w/ cycle slipping and w/o cycle slipping

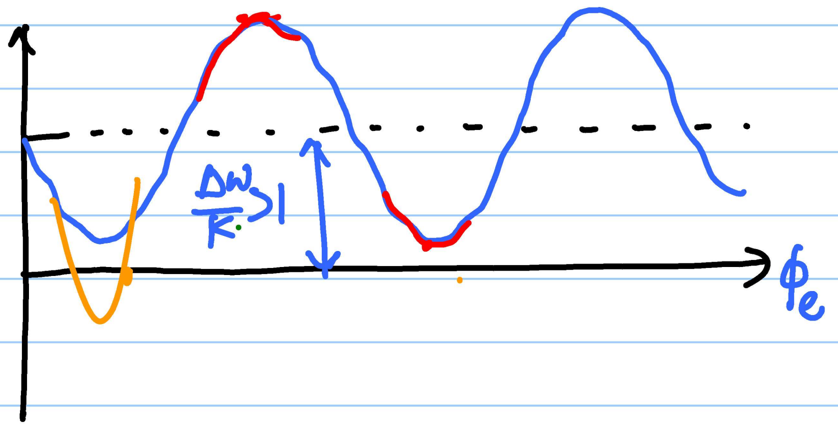
w/ ϕ_e exceeding 2π and w/o ϕ_e exceeding 2π

$\Delta\omega(0) \leq K$

$\phi_e = \Delta\omega(0) \cdot t - \int K_{vco} v_e \cdot dt$



$v_e = \frac{1}{2}\sin(\phi_e)$



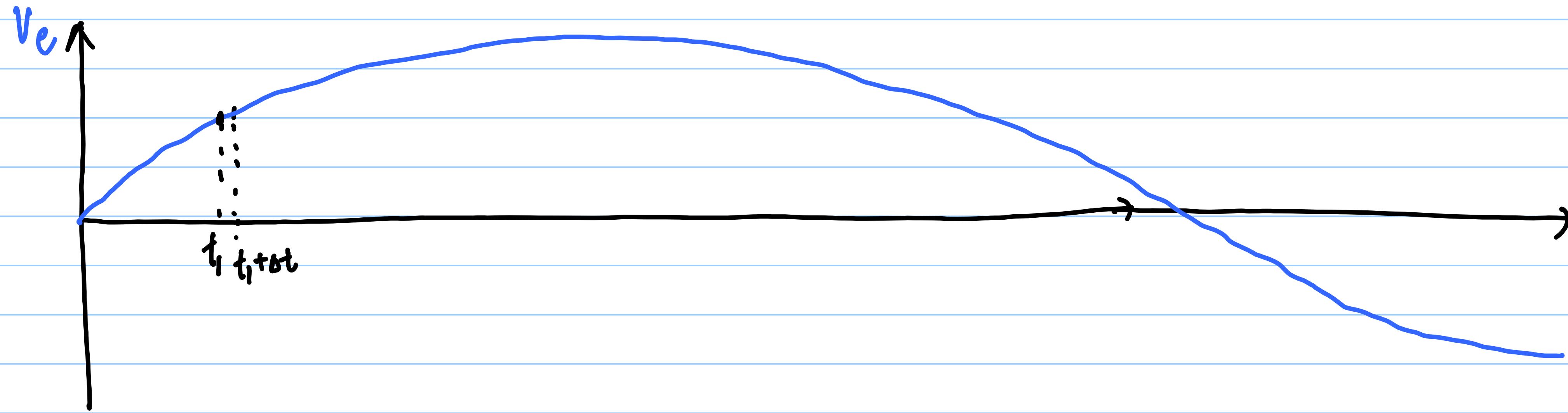
$V_e = v_e = \frac{1}{2}\sin(\phi_e)$

$\phi_e(t) = \Delta\omega(0)t - \frac{K_{vco}}{2}\int \sin(\phi_e(t'))dt'$

$\approx \Delta\omega(0)t - \frac{K_{vco}}{2}\int \sin(\Delta\omega t)dt$

$$\phi_e(t) = \Delta\omega(0).t + \frac{K_{vco}}{2}\left(\frac{\cos(\Delta\dot{\omega}.t)}{\Delta\omega'}\right)$$

ϕ



$$\phi_e(t) = \Delta\omega(0).t - \frac{\dot{K}_{vco}}{2}\int \sin(\phi_e(t))\,dt$$

at $t=0$. : $\phi_e = 0$

$t=0+\Delta t$: $\phi_e = \Delta\omega(0).\Delta t - \frac{K_{vco}}{2}\int \sin(0)\,dt$

$t=0+2\Delta t$: $\phi_e = \Delta\omega(0).2\Delta t - \frac{K_{vco}}{2}\int \sin(\phi_e)\,dt$